

## A Brief History of Biospeleology in Virginia

John R. Holsinger

Department of Biological Sciences  
Old Dominion University  
Norfolk, Virginia 23529

### ABSTRACT

The study of cave biology or biospeleology in Virginia had its beginning in the second part of the 19th century with two papers published by E. D. Cope followed by a monograph in 1888 by A. S. Packard. Packard's extensive work resulted from his observations on caves in Kentucky, Indiana, and Virginia. Following a period of inactivity, biological study of North American caves was resumed in the 1930s with investigations by both American and European workers, presumably driven by the rapidly increasing interest in evolutionary biology. Explanations for the loss of eyes, pigment, and attenuation of appendages in cave animals were especially interesting. Beginning in the 1950s and continuing until the present time, both extensive and intensive investigations of caves and their biotas have been carried out and many new species of insects and crustaceans have been discovered and described. One of the most remarkable has been the discovery of the marine relict isopod *Antrolana lira* from Madison Saltpetre Cave. Concurrent with a rapidly developing interest in both the biology and geology of caves, a "formal" Biological Survey of Virginia Caves was initiated in the early 1960s and resulted in a publication in 1988 titled "The invertebrate cave fauna of Virginia and a part of eastern Tennessee: zoogeography and ecology." Subsequent to this publication, collecting has continued on a reduced scale paralleled by ecological studies by graduate students. Long-term studies on ecology, biological monitoring, and conservation of specific caves continue as well.

**Key words:** biospeleology, Edward Drinker Cope, A. S. Packard, Madison's Cave, troglomorphic, Burkes Garden, Thomas C. Barr, Jr., Biological Survey of Virginia Caves, Virginia Natural Heritage Program.

The study of cave biology or biospeleology had its beginning in Virginia in approximately 1869 with a paper published by Edward Drinker Cope, who recorded beetles and millipeds he collected from caves two years earlier in Giles and Montgomery counties (Cope, 1869; Grady, 1987). This early acknowledgement of living organisms in caves is one of the first scientific documentations of subterranean animal life in North America and is probably the first listing of cave-adapted animals in Virginia. A few years later, Cope (1872) described the subterranean amphipod crustacean genus *Stygobromus* based on specimens collected in Mammoth Cave, Kentucky. Subsequently, many species of this genus have been discovered and described from Virginia caves as well as elsewhere in North America and Asia (e.g., Holsinger, 1967, 1978, 2009). It is interesting that Cope, who is usually thought of as primarily a paleontologist, also made these early collections and descriptions of arthropods. Nevertheless, Cope's significant work was soon overshadowed by the extensive biospeleological

research in Virginia and other parts of eastern North America by A. S. Packard (1888), who published an important monograph titled "The cave fauna of North America, with remarks on the anatomy of the brain and origin of the blind species" in *Memoirs of the National Academy of Sciences*. Notably, Packard's principal observations and collections were based primarily on his visits to the relatively well known and easily accessible "show" caves in Virginia, Kentucky, and Indiana at a time when literally nothing was known about thousands of other caves that would be discovered and explored in North America in the years to follow. In Virginia, these early known "show" caves were all in the Shenandoah Valley and included Fountain, Grand (formerly Weyer's), and Madison's in "Cave Hill" near the town of Grottoes; Endless or Zirkles Cave near New Market; and Luray Cave (now Luray Caverns) near the town of Luray. Elsewhere, Packard visited and collected specimens from Wyandotte Cave in southern Indiana, Mammoth Cave in central Kentucky, and a few others. Prior to

publication of Packard's extensive volume, literally nothing was known about the numbers or kinds of organisms that lived in the subterranean ecosystems of North American caves.

It is interesting that prior to the early works of Cope and Packard at least one cave in Virginia was visited by both George Washington and Thomas Jefferson in the early part of the 19<sup>th</sup> century. Although neither was a biologist, both were apparently interested in natural history, and their visits to a cave later called Madison's Cave (more recently Madison Saltpetre Cave) probably marked the beginning of speleology in Virginia. Moreover, Jefferson's "eye draught" map of Madison's Cave is one of the first maps of a cave in America (see Halliday, 1968). Also of historical interest is the fact that Packard mistakenly referred to Fountain Cave as nearby Madison's Cave in his 1888 monograph. It is unfortunate that Packard did not visit Madison's Cave. This cave is clearly the most biologically significant of the three Cave Hill caves and data from there would have enhanced Packard's work.

Following Packard's extensive publication in 1888, little was written about the exploration of caves, their geological origins, or biological contents during the next 20 years. This apparent lack of interest in cave science seems to have extended well into the early part of the 20<sup>th</sup> century and is surprising in view of the excitement that one would have expected from the earlier papers of Cope and Packard. However, all of this changed in the 1920s and early 1930s. During this period, American coleopterists S. Barber and J. M. Valentine and European biospeleologists C. Boliver and René Jeannel made extensive collections of invertebrates (primarily insects) from Virginia caves and published their findings in a series of papers that followed their visits. This new awakening of biospeleological activity appears to have occurred simultaneously with a renewed interest in cave exploration and documentation. Following the lag of speleological activity in the early 20<sup>th</sup> century, the 1930s also witnessed a merger of taxonomic and genetic thinking and development of the so-called "synthetic theory" in evolutionary and systematic biology (see Mayr, 1963). It followed that blind, unpigmented animals, often with attenuated appendages, living in caves demanded attention and an explanation for their loss of eyes and pigment and development of other "troglomorphic" characters common to cave-adapted organisms. This newly developing emphasis on evolutionary biology in the 1930s clearly had a significant effect on the renewed interest in cave animals, not just in Virginia, but elsewhere in America as well.

From the late 1930s well into the 1950s, in concert with the developing interest in evolutionary biology and exploration and documentation of caves, a number of both American and European biologists collected specimens from caves in Virginia and adjoining states. These workers and their taxonomic group(s) of interest included Kenneth Dearolf (general collecting), Leslie Hubricht (Fig. 1; crustaceans and snails), J. P. E. Morrison (snails), Henri Henrot (crustaceans), and Bruno Condé (diplurans). These collections resulted not only in descriptions of many interesting new species but provided significant new information on the ecology and biogeography of cave-adapted animals.

Probably the most remarkable Virginia cave biology story to emerge from the 1950s involved a collecting trip to southwestern Virginia by Bruno Condé from Nancy, France. Condé came to Washington, D.C. in 1955 to attend an international zoological meeting. While in close proximity to the Appalachian cave region, Condé planned to use this occasion to visit Lawson Cave in southwestern Virginia from which he had seen specimens of an interesting, undescribed dipluran insect that he hoped to describe and study in more detail. Because this cave was in Virginia, Condé believed it would be easy for him to travel to it and collect additional specimens during his visit to the U.S. Little did he know that Wytheville, the only town of any size "close" to Lawson Cave in Burkes Garden, was approximately 250 miles from D.C. in "distant" southwestern Virginia. Determined to visit this cave,

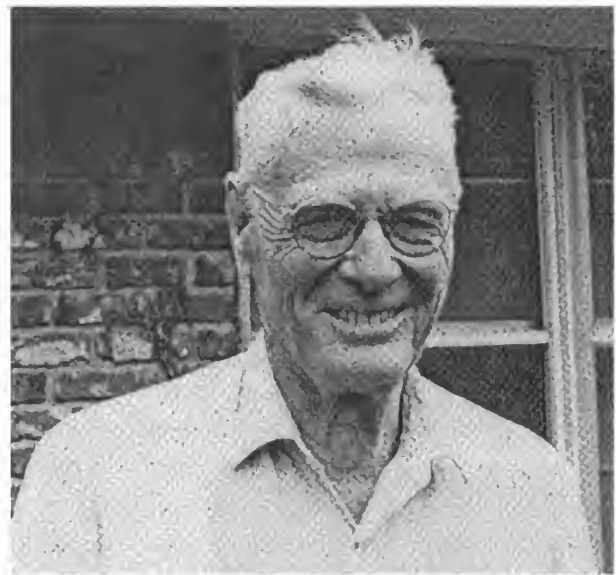


Fig. 1. Leslie Hubricht, an early collector of aquatic cave and spring organisms in Virginia and elsewhere in eastern North America.

Condé took what must have been at the least a 12-hour trip by Greyhound bus from Washington, D.C. to Wytheville. Once in Wytheville he was told that Burkes Garden was in a remote, high elevation valley in the mountains some 20 miles to the northwest. The only road to Burkes Garden from Wytheville was an unimproved, gravel-bedded Forest Service road. Amazingly, Condé was able to talk a cab driver into taking him to Burkes Garden. Once at the cave, he paid the cabbie to wait while he collected diplurans. Apparently everything went as planned and Condé found numerous diplurans on a mud bank in the cave. He returned to Wytheville and took a bus back to D.C. In telling this fantastic story to a group of colleagues, at a meeting of subterranean biologists many years later in Moulis, France, Condé never said how long these bus rides lasted or how he found Lawson Cave once he reached Burkes Garden. However, in those days there were no interstate highways and the road across the mountain to Burkes Garden wasn't much more than a narrow, winding, unimproved graveled pathway with hairpin curves and switchbacks. One can only imagine what the locals thought when they encountered this vivacious French zoologist who had traveled all the way to Tazewell County from Europe to collect tiny, white, eyeless insects from a cave in remote Burkes Garden. Whatever the obstacles, Condé returned to France with a nice collection of insects and a great story to tell his colleagues.

Following the renewed biological interest in caves in the 1930s and 1940s, Thomas C. Barr, Jr. (Fig. 2), a biospeleologist from Tennessee, made an extensive collecting trip through western Virginia in 1958, where he visited 37 caves. Although Barr's primary goal was to collect trechine cave beetles in the genus *Pseudanophthalmus*, one of his most important discoveries was finding a rare, marine relict cirolanid isopod in a deep lake in Madison Saltpetre Cave in Augusta County. This new, biogeographically significant isopod was subsequently described by Thomas C. Bowman, a curator of Crustacea at the Smithsonian Institution, and named *Antrolana lira* (Bowman, 1964). Originally believed to be extremely rare and restricted to a single subterranean aquifer, *A. lira* was placed on the Federal Threatened Species List. Although now known to be more common and widespread than first thought, it is nevertheless one of the most significant cave-adapted animals in eastern North America (Holsinger et al., 1994), and its protection as a "threatened species" is clearly warranted.

In the early 1960s, in concert with the renewed interest in cave exploration and documentation and the potential for finding undescribed new species as well as



Fig. 2. Dr. Thomas C. Barr, Jr. collecting cave beetles from an Appalachian cave.



Fig. 3. Drs. John R. Holsinger (left) and John E. Cooper (right) in front of Showalter's Cave, Rockbridge Co., VA on a collecting trip in May 1961 that marked the beginning of the "Biological Survey of Virginia Caves" project.

a need for additional data on the systematics and ecology of cave organisms, an extensive biological survey of caves in Virginia was initiated by the author. This newly developed project named the "Biological Survey of Virginia Caves" was first assisted by John E. Cooper (Fig. 3) and later joined by David C. Culver (Fig. 4). It was subsequently expanded to include the contiguous karst areas of upper eastern Tennessee. The results of this study, which were based on collections and observations in approximately 500 caves in Virginia and northeastern Tennessee, were published in



Fig. 4. Dr. David C. Culver collecting “cave-like” crustaceans from a groundwater seep in the Piedmont of eastern Virginia just west of the Appalachian cave region.

a monograph titled “The invertebrate cave fauna of Virginia and a part of eastern Tennessee: zoogeography and ecology” by Holsinger & Culver (1988). It is perhaps of interest that publication of this monograph was on the 100 year anniversary of Packard’s earlier monograph. Approximately 335 species of invertebrate animals, representing some 90 families and 173 genera, were recorded from caves in the study area.

A companion to the Biological Survey of Virginia Caves was developed later to include the adjacent karst region in neighboring West Virginia. The West Virginia Cave Survey data were published in Bulletin 7 of the West Virginia Speleological Survey by J. R. Holsinger, R. Baroody, and D. C. Culver (1976). A revised and updated edition of this monograph was published recently as Bulletin 16 of the West Virginia Speleological Survey (Fong et al., 2007). A similar revision and update of the invertebrate cave fauna of Virginia by J. R. Holsinger, D. C. Culver, D. A. Hubbard, Jr., W. D. Orndorff, and C. S. Hobson has been completed and appears as the next paper in this issue of *Banisteria*.

Subsequent to the publication by Holsinger & Culver (1988), collecting in Virginia caves has continued on a reduced scale, consisting primarily of obtaining specimens from caves newly discovered since 1988 and returning to previously studied caves for additional specimens and ecological observations. However, many new records, including additional undescribed species, were obtained during the 1990s by David A. Hubbard, Jr. (Fig. 5), who visited many caves while simultaneously collecting geological data for a state “Karst Map” being developed by the Virginia Division of Mineral Resources. More recently, biological studies of caves have concentrated on gathering pertinent data on the ecology and

biogeography of specific taxa in some of the state’s most important biologically significant caves. Paralleling these studies has been a number of important conservation efforts as well. These include acquisition and/or long-term protection of biologically significant caves by the Virginia Natural Heritage Program and the Cave Conservancy of the Virginias (CCV), and the development of protective measures for karst drainage basins associated with large cave systems.

Beginning in the early to middle 1970s, there have been a number of important studies by former graduate students (Fig. 6) working on the systematics and/or ecology of specific taxa or on the ecology of the fauna of a selected cave. The results of much of this important research is published and readers are referred to the bibliography in Holsinger & Culver (1988) for a complete listing of the published research papers based on projects completed in the 1970s and 1980s. Briefly, these projects included research on the ecology of the amphipod *Gammarus minus* by Steven W. Hetrick; population ecology of *Antrolana lira* in Madison Saltpetre Cave and nearby Stegers Fissure by T. Lynn Collins; a series of papers on the ecology of the amphipod crustacean *Crangonyx antennatus* in Lee County by Gary W. Dickson; ecology of the isopod crustacean *Lirceus usdagalum* in Thompson Cedar Cave combined with assistance on the description of the sister species *Lirceus culveri* in Rye Cove by James A. Estes; systematics and biogeography of dipluran insects in the family Campodeidae by Lynn M. Ferguson and additional biological collecting; and taxonomy of

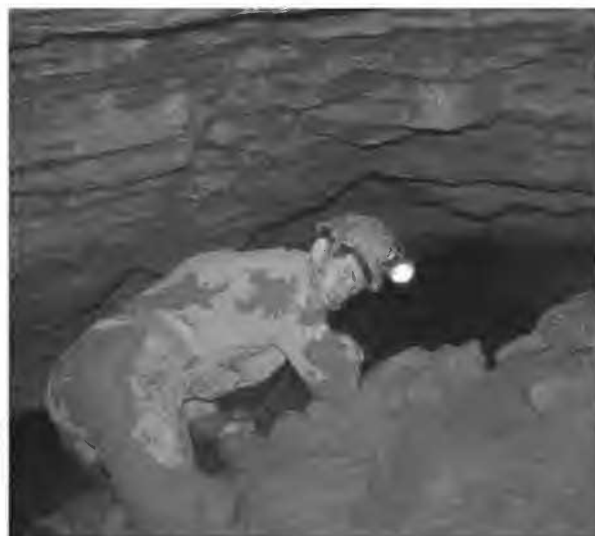


Fig. 5. David A. Hubbard, Jr., collected extensively in Virginia caves during the 1990s (photo courtesy of Lynn M. Ferguson).



Fig. 6. Three former Ecological Science graduate students from Old Dominion University collecting crustaceans from a cave stream in Lee County.

asellid isopods in the genus *Caecidotea* by Julian J. Lewis and Lawrence E. Fleming. The most recent graduate student research was carried out by Ben Hutchins on the genetic structure of the Madison Cave Isopod under the direction of Daniel W. Fong and David B. Carlini at American University (Hutchins et al., 2010). In addition to the flourish of graduate student research during the period described above, Robert Hershler, a curator of Mollusca at the Smithsonian Institution, described *Holsingeria unthinksensis*, a rare new hydrobiid snail from a stream in Unthinks Cave in Lee County (Hershler, 1989).

In the last few years, personnel of the Virginia Department of Conservation and Recreation's Division of Natural Heritage have also become involved in long-term, biological monitoring of selected caves, with special emphasis on the conservation and protection of the Federally Threatened Madison Cave Isopod and the Federally Endangered Lee County Cave Isopod, *Lirceus usdagalun*. A recent study, involving personnel from both local universities and the state's Natural Heritage Program is underway to precisely determine the relationship between deep groundwater aquifers and the geographic distribution of the Madison Cave Isopod in the Shenandoah Valley karst region of western Virginia and eastern West Virginia. In addition, efforts are being made by personnel of the Heritage Program's Karst Protection group and the Virginia Department of Game and Inland Fisheries (VDGIF) to record and monitor the distribution and detrimental effects of White Nose Syndrome (WNS) on the state's bat populations. Although not affected to date by WNS, the lone maternity colony in Virginia of the Federally

Endangered Virginia Big-eared Bat (*Corynorhinus townsendii virginianus*) in a cave in Burkes Garden is routinely monitored by VDGIF personnel.

What is in the future for cave biology research in Virginia? Many new caves have been discovered in recent years and many more remain to be found. In addition, new passages in previously known caves continue to be discovered. Currently, based on the Virginia Speleological Survey database, the number of recorded caves in the state is approximately 3,000, excluding tight fissures, crevices, and most rock shelters. It is of further interest that five of these caves are greater than 10 miles in length, 17 are greater than 5 miles in length, and many more are longer than 1 mile. Biological exploration of newly discovered caves and/or passages in previously known caves have the potential for discovery of new species and perhaps new genera, and range extensions for previously known species. In addition, discovery of new taxa can lead to important new studies on their evolution, ecology, and biogeography.

#### ACKNOWLEDGMENTS

I am grateful to the following colleagues who were kind enough to read an earlier draft of this paper and provide additional information and suggestions for improvement: John E. Cooper, David C. Culver, Daniel W. Fong, Julian J. Lewis, the late Thomas C. Barr, Jr., Lynn M. Ferguson, and Wil Orndorff. Mike Futrell provided current data from the Virginia Speleological Survey on the number of caves in the state. In addition, I thank the many taxonomists who have provided identifications and/or descriptions of taxa from Virginia caves over the years. Their contributions have added immensely to our knowledge of Virginia's significant cave fauna. A near complete list of these workers can be found under "Acknowledgments" on page 146 in Holsinger & Culver (1988).

#### LITERATURE CITED

- Bowman, T. E. 1964. *Antrolana lira*, a new genus and species of troglobitic cirolanid isopod from Madison Cave, Virginia. *International Journal of Speleology* 1: 229-236.
- Cope, E. D. 1869. Synopsis of the extinct Mammalia of the cave formations in the United States, with observations on some Myriapoda found in and near the same, and on some extinct mammals of the caves of Anguilla, W. I., and of other localities. *Proceedings of the American Philosophical Society* 11: 171-192.



- Cope, E. D. 1872. On the Wyandotte Cave and its fauna. *American Naturalist* 6: 406-422.
- Fong, D. W., D. C. Culver, H. H. Hobbs, III, & T. Pipan. 2007. The Invertebrate Cave Fauna of West Virginia. Second Edition. West Virginia Speleological Survey Bulletin No. 16. 163 pp.
- Grady, F. 1987. Edward Drinker Cope's contributions to speleology. *Journal of Spelean History* 21: 37-38.
- Halliday, W. R. (ed). 1968. The grottoes of the Shenandoah. *Journal of Spelean History* 1: 20-43.
- Hershler, R. 1989. *Holsingeria unthinksensis*, a new genus and species of aquatic cavesnail from eastern North America. *Malacological Review* 22: 93-100.
- Holsinger, J. R. 1967. Systematics, speciation, and distribution of the subterranean amphipod genus *Stygonectes* (Gammaridae). United States National Museum Bulletin No. 259. 176 pp.
- Holsinger, J. R. 1978. Systematics of the subterranean amphipod genus *Stygobromus* (Crangonyctidae), Part II: species of the eastern United States. *Smithsonian Contributions to Zoology* No. 266. 144 pp.
- Holsinger, J. R. 2009. Three new species of the subterranean amphipod crustacean genus *Stygobromus* (Crangonyctidae) from the District of Columbia, Maryland, and Virginia. Pp. 261-276 *In* S. M. Roble & J. C. Mitchell (eds.), *A Lifetime of Contributions to Myriapodology and the Natural History of Virginia: A Festschrift in Honor of Richard L. Hoffman's 80<sup>th</sup> Birthday*. Virginia Museum of Natural History Special Publication No. 16, Martinsville, VA.
- Holsinger, J. R., R. Baroody, & D. C. Culver. 1976. The Invertebrate Cave Fauna of West Virginia. West Virginia Speleological Survey Bulletin No. 7. 82 pp.
- Holsinger, J. R., & D. C. Culver. 1988. The invertebrate cave fauna of Virginia and a part of eastern Tennessee: zoogeography and ecology. *Brimleyana* 14: 1-162.
- Holsinger, J. R., D. A. Hubbard, Jr., & T. E. Bowman. 1994. Biogeographic and ecological implications of newly discovered populations of the stygobiont isopod crustacean *Antrolana lira* Bowman (Cirolanidae). *Journal of Natural History* 28: 1047-1058.
- Hutchins, B., D. W. Fong, & D. B. Carlini. 2010. Genetic population structure of the Madison Cave isopod, *Antrolana lira* (Cymothoidea: Cirolanidae) in the Shenandoah Valley of the eastern United States. *Journal of Crustacean Biology* 30: 312-322.
- Mayr, E. 1963. *Animal Species and Evolution*. Belknap Press of Harvard University Press, Cambridge, MA. 797 pp.
- Packard, A. S. 1888. The cave fauna of North America with remarks on the anatomy of the brain and origin of the blind species. *Memoirs of the National Academy of Sciences* 4: 1-156.



Exterior and interior views of the entrance to Surgener Cave in Lee County, one of Virginia's most biologically significant caves. Photos by John R. Holsinger.